PROTECTA
Electronics Co. Ltd

EuroProt

complex protection

DTI3-MV-EP

factory configuration

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1 Application

The members of the **EuroProt** complex protection series are basically modular devices. The modules are assembled and configured according to the required protection functions. This manual describes the specialities of one of the numerous applications: the **DTI-MV-EP** factory configuration (and its versions). The general user's manual for the **EuroProt** devices is the document „EPCP-2004 EuroProt complex protection, hardware and software manual", (further „*EPCP-2004*"), which provides all common information to the members of the **EuroProt** complex protection series.

The **DTI-MV-EP** complex numerical device made by PROTECTA Co. Ltd. is pre-configured for a three-phase definite time overcurrent protection with earth-fault protection. This device can be applied in all areas of the electric power system, where overcurrent protection is needed to protect against short-circuits, overload or earth fault.

The additional supervisory and control functions (SCADA) extend the device to a complex field unit.

1.1 Features

The main features of **DTI-MV-EP** complex protection are as follows:

- The protection part of the complex device implements the following functions:
  - three-phase, definite time overcurrent protection, high current setting stage (I>>),
  - three-phase, definite time overcurrent protection, low current setting stage (I>),
  - zero sequence overcurrent function, high current setting stage (3Io>>),
  - zero sequence overcurrent function, low current setting stage (3Io>>), can be set for directional earth-fault protection as well,
  - zero sequence overvoltage protection,
  - over/undervoltage protection based on the phase voltages.
- Features of the protection functions:
  - all functions can be individually switched to be operative or inoperative;
  - the setting value and time delay of the functions can be set independently of each other,
  - the zero sequence low current setting stage can be set for directional earth-fault protection as well.
- Additional features:
  - trip matrix,
  - PROTLOG equations.

- The features of the supervisory and control functions implemented in the device are as follows:
  - the supervisory and control functions are implemented in a dedicated processor, located on the Central Processing Unit (CPU) of the device,
  - the optional large graphic LCD realises full-scale local control unit for the bay,

- the supervisory and control functions are as follows:
  - control of switching devices:
  - local and remote operation,
  - interlocking functions,
  - generation of status signals,
  - event logging,
  - protective command transmission,
  - communication with the intelligent graphic display,
  - transmission of protection signals to the supervisory and control system,
  - transmission of commands signals from the supervisory and control system, and their execution,
  - receipt of commands from the graphic LCD and their execution.

- Continuous and cyclic self-check functions are implemented; the supervision is extended to the current transformer circuits and to the trip circuits as well.
- The same software configuration is loaded in all configurations of the device. The individual functions of the software are to be set by parameters according to the requirements. The versions are basically determined by the hardware configuration.
- The integrated event recorder can store up to 50 evaluated events and up to 300 digital events with 1 ms time resolution.
- An integrated real-time clock is implemented with battery supported RAM. The clock can be synchronised by external PC or by the supervisory and control system, and additionally a Word Time Synchroniser (GPS-OP) produced by PROTECTA Co. Ltd can be ordered optionally.
- The integrated disturbance recorder of the CPU module can store up to 11 records, the total time of which is about 10 s.
- The device implements several measuring functions based on the available analogue signals.

1.2 Main hardware features

The **DTI-MV-EP** complex digital overcurrent protection is a full numerical system, based on powerful microcontrollers. Within the limits of the hardware the functions and the versions are determined by the software.

The different hardware versions of the device – with identical software – cover practically all usual protective functions of the medium voltage part of the electric power system.

The hardware versions are as follows:

ID	Meaning
3FIo	3 phase + zero sequence current measurement (the zero sequence current can be directed by calculated Uo zero sequence voltage)
3FU	3 phase voltage measurement (calculated Uo)
xK	number of relay outputs (max. 24)
XD	number of optically isolated inputs (max. 32)
UKE	unit for trip circuit supervision

The maximum possible configuration:

EuroProt complex protection:
DTI-MV-EP factory configuration
HW version: 3FIo-3FU-24K-32D-UKE

Minimum configuration:

EuroProt complex protection:
DTI-MV-EP factory configuration
HW version: 3FIo -8K-42TE

The design, and the man-machine interface of the device is described in „*EPCP-2004*" manual.

The man-machine interface of the device is the integrated 2x16 character LCD, the simple keyboard with 6 pushbuttons and the 7 LED-s on the front panel. The device can be supervised easier with a connected PC, which runs the windows-based operating program „Protect for Windows", developed by Protecta Co. Ltd. The user's manual for all these possibilities is the „*EPCP-2004"* documentation.

The medium for the external communication is the 2 kV isolated serial RS 232 interface located on the front panel of the device, or the two integrated fibre optic interfaces, connector son the back panel. For the serial communication please find detailed information in the „*EPCP-2004*" documentation.

2 The protection functions

The DTI-MV-EP complex numerical protection implements the following protection functions:

- Definite time overcurrent protection for phase faults
- Zero sequence overcurrent protection for earth-faults (with optional direction function)
- Zero sequence overvoltage protection
- Over/undervoltage protection for phase voltages

These functions are independent of each other, they can be set individually. The functions can be individually set to be operative or inoperative. The following chapters describe the protection functions.

2.1 Definite time overcurrent protection for phase faults

One of the basic functions of the complex protection is the definite time overcurrent protection for phase faults.
The algorithm determines the basic harmonic component of the phase currents using Fourier method, and this value is compared with the settings. If the basic harmonic content of one phase current is above the setting, the function starts the timer. When the pre-set time is over the function generates trip command.

2.1.1 Realisation of the three phase, two stage overcurrent protection

The **DTI3-MV-EP** factory configuration of the EuroProt devices implements a three-phase, two stage definite time overcurrent protection. The measurement is performed in all three phases independently of each other, and the comparison with the two setting values (high current setting, low current setting) is performed individually as well. The measurement of the elapsed time however is common for all phases, and the trip command is issued common for the three phases as well.

2.1.1.1 Analogue inputs of the function

This function measures the three phase currents:

Ir
Is
It

2.1.1.2 The parameter setting

The function needs setting of the following parameters:

Name	LCD	Min	Max	Step	Meaning
PIn	I> /In[CTprot) = %	20	2500	5	Setting of the low current setting stage related to the CT rated current
PInn	I>> /In[CTprot) = %	20	2500	5	Setting of the high current setting stage related to the CT rated current
PAV	CTprN ['CTprot] = A	15	15000	5	CT primary rated current related to 1A or 5A secondary value
PTIn	t (I>) = ms	0	60000	10	Selective time delay of the low current setting stage
PTInn	t (I>>) = ms	0	60000	10	Selective time delay of the high current setting stage
E_InEng	(setting with PROTLOG equation only!)	0	1	1	Enabling of the low current setting stage
E_InnEng	(Setting with PROTLOG equation only!)	0	1	1	Enabling of the high current setting stage
PMxsInntOnt	I>>[t] latching: /+=yes/	-	+		Latching of the matrix row for the high current setting stage time-over
PMxsIntOnt	I>[t] latching: /+=yes/	-	+		Latching of the matrix row for the low current setting stage time-over

Parameter setting of the function on the „On-line" PC screen of the Protect for Windows software:

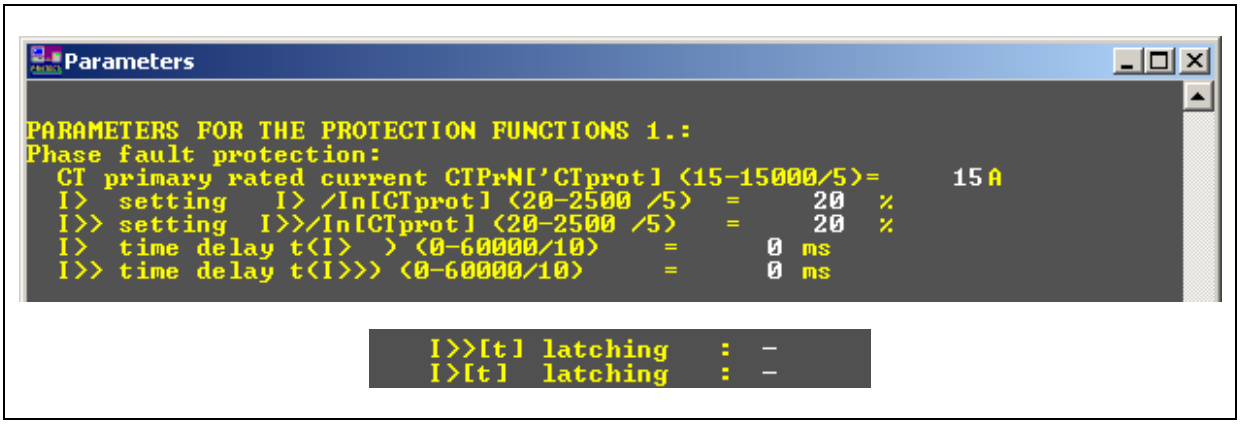
Parameters
PARAMETERS FOR THE PROTECTION FUNCTIONS 1.:
Phase fault protection:
CT primary rated current CTPrN['CTprot] (15-15000/5)= 15 A
I> setting I> /In[CTprot] (20-2500 /5) = 20 %
I>> setting I>>/In[CTprot] (20-2500 /5) = 20 %
I> time delay t(I>) (0-60000/10) = 0 ms
I>> time delay t(I>>) (0-60000/10) = 0 ms
I>>[t] latching : -
I>[t] latching : -

Fig. 2-1. Parameter setting /1

The enabling of the functions is solved with „PROTLOG" logic equations. As an example the enabling of the high current setting stage can be:

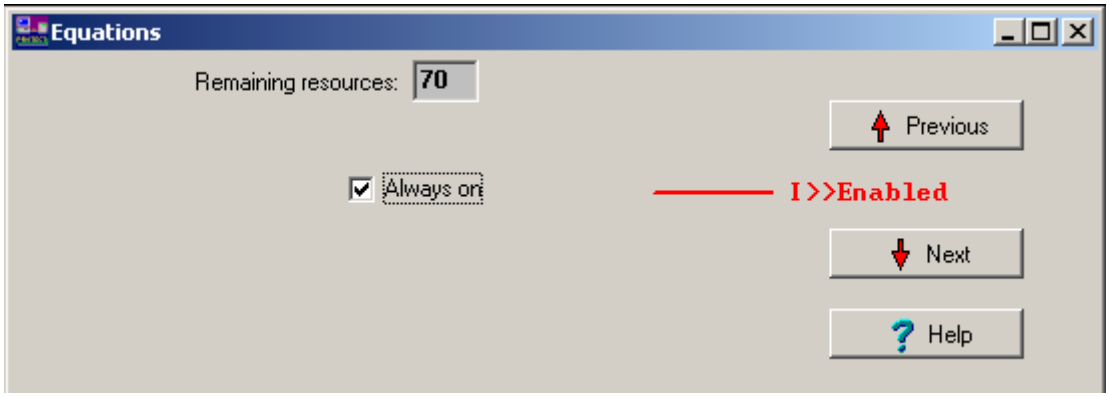

Fig. 2-2. Enabling the functions with „PROTLOG" logic equation

2.1.1.3 Outputs of the function

The functions deliver status signals indicating the operation. Among others these will be the inputs (rows) of the software matrix. These inputs can be marshalled with matrix programming to the outputs (columns) of the matrix. The status signals of the functions can be inputs of the „PROTLOG" logic equations as well.

The matrix rows of the phase overcurrent protection function are:

Matrix row	Explanation
`Mx I(rst)>>`	Starting of the high current setting stage in any of the phases
`Mx I(rst)>`	Starting of the low current setting stage in any of the phases
`Mx (rst)>>[t]`	Time-over in the high current setting stage (trip command)
`Mx I(rst)>[t]`	Time-over in the low current setting stage (trip command)

These signals can be marshalled with the software matrix to the output relays of the device. Fig 2-3 below shows that output relay contact No.1 outputs the trip command. Starting of the high current setting stage is signalled with contact No. 2, and contact No. 3 signals starting of the high current setting stage.

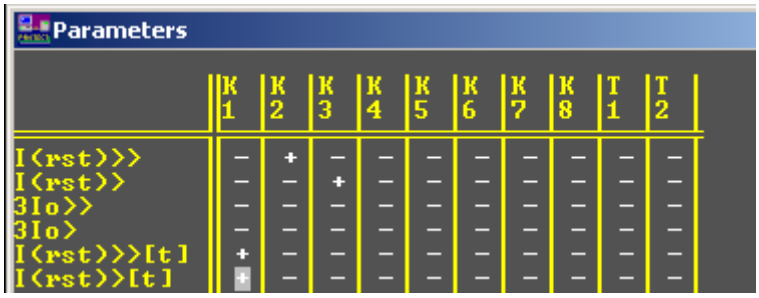

Fig. 2-3. Marshalling of the outputs of the function (matrix rows) to the output relays of the device (matrix columns)

2.1.1.4 Inputs of the PROTLOG equations:

Input	Explanation
Ir>> Is>> It>>	Starting of the high current setting stage in the indicated phase
Ir> Is> It>	Starting of the low current setting stage in the indicated phase
I>>[t]	Time-over in the high current setting stage (trip command)
I>[t]	Time-over in the low current setting stage (trip command)

2.1.1.5 The displayed information

Displayed information on the integrated LCD of the device, in the „*Test*" menu:

Measured analogous signals:

LCD information	Explanation
Ir[A]=	Primary current in phase R expressed in Amperes
Is[A]=	Primary current in phase S expressed in Amperes
It[A]=	Primary current in phase T expressed in Amperes

Binary signals on the PC screen:

Signal	Explanation
I>>enabled :	High current setting stage enabled
Ir>> start :	Starting of the high current setting stage in phase R
Is>> start :	Starting of the high current setting stage in phase S
It>> start :	Starting of the high current setting stage in phase T
I>>[t] timeout:	Trip command of the high current setting stage (time-over)
I> enabled :	Low current setting stage enabled
Ir> start :	Starting of the low current setting stage in phase R
Is> start :	Starting of the low current setting stage in phase S
It> start :	Starting of the low current setting stage in phase T
I>[t] timeout :	Trip command of the low current setting stage (time-over)

The „On-line" screen of the Protect for Windows program shows this information, as indicated in Fig. 2-4. (Information related to other protection functions are masked in the Figure):

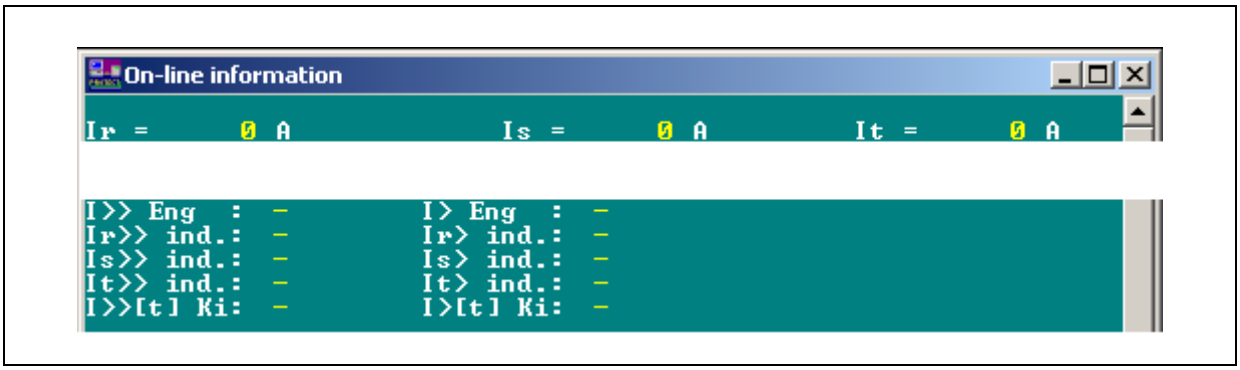

Fig. 2-4. On-line data /1

Currents are indicated in primary Amperes. In case of overcurrent stages „+" character signals staring of the function and the generation of the trip command.

2.1.1.6 Messages of the function:

There is only one message related to the function:

```
Trip command!
```

To enable this message a „PROTLOG" logic equation must be composed for the „`Trip command`" logic variable. Fig. 2-5 sows an example:

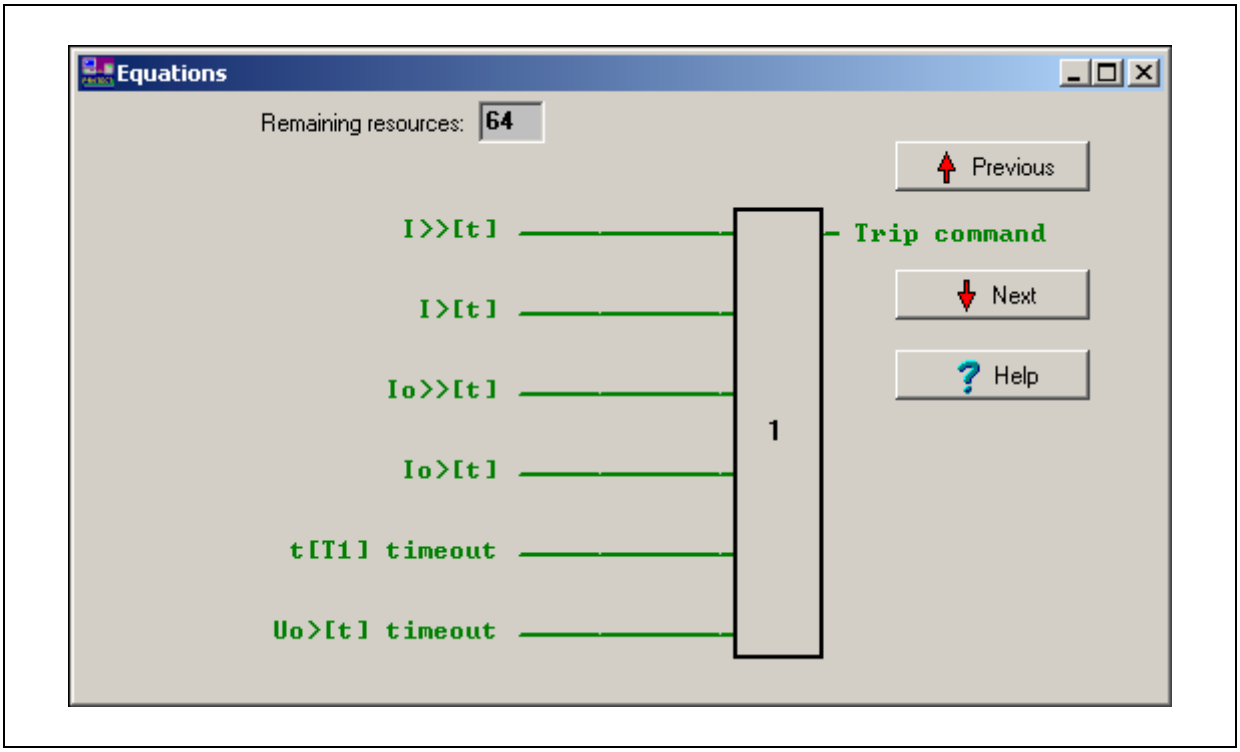

Fig. 2-5.PROTLOG equation for the message

2.1.1.7 Event recording

The event recorder function records the following events with time stamp. See details of event recording in the „*EPCP-2004* documentation. The integrated LCD of the device can display the following messages:

```
"I>>R start      "
"I>>S start      "
"I>>T start      "
"I>R  start      "
"I>S start       "
"I>T start       "
"I>[t] timeout   "
"I>>[t] timeout  "
```

2.1.1.8 Evaluated events

The Protect for Windows software displays the evaluated event in a separate window according to Fig. 2-6.:

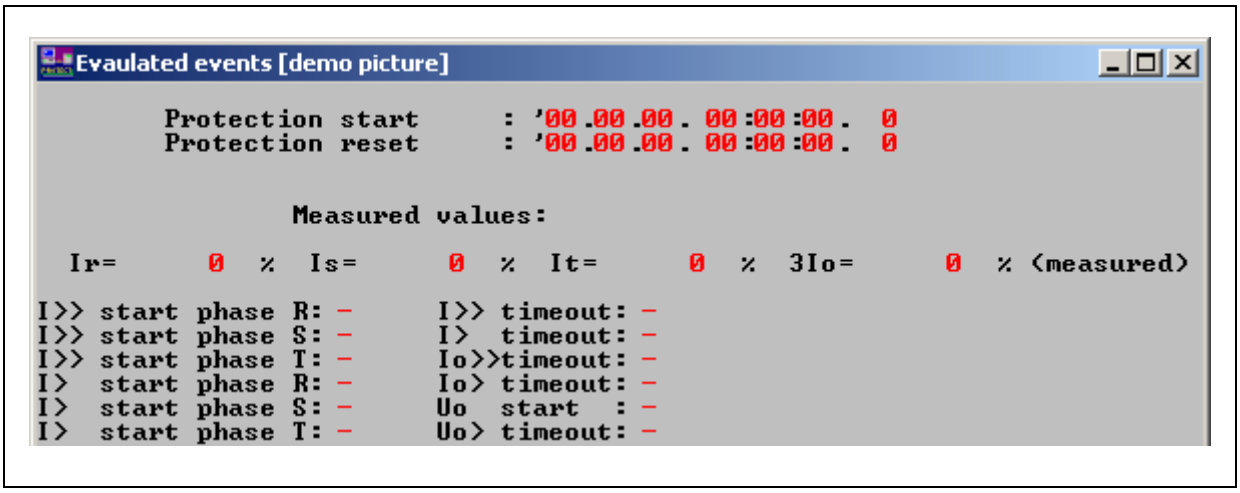
Evaulated events [demo picture]
Protection start : '00.00.00. 00:00:00. 0
Protection reset : '00.00.00. 00:00:00. 0
Measured values:
Ir= 0 % Is= 0 % It= 0 % 3Io= 0 % (measured)
I>> start phase R: - I>> timeout: -
I>> start phase S: - I> timeout: -
I>> start phase T: - Io>>timeout: -
I> start phase R: - Io> timeout: -
I> start phase S: - Uo start : -
I> start phase T: - Uo> timeout: -

Fig. 2-6. Evaluated events /1

2.1.1.9 Event counters

The phase overcurrent function involves the following counters (displayed on the integrated LCD of the device):

```
I>[t]  counter : 8
I>>[t] counter : 3
```

The counter values are displayed in the „On-line" PC screen as shown in Fig. 2-7.:

Fig. 2-7. Counters /1

2.1.1.10 LED indication

The operation of the functions integrated into the device is indicated by seven LED-s located on the front panel. The LED-s shown in the following table are related to the phase overcurrent protection (LEDs are numbered from top to bottom):

LED No.	LED text	Explanation
4	IS	Starting in phase S
5	IT	Starting in phase T

6	I>>	High set current stage start
7	I>	Low set current stage start

2.1.1.11 Signals recorded in the disturbance recorder

The integrated disturbance recorder records the following signals:

Analogue signals:

Signal	Explanation
Ir %	Current in phase R as percent of the CT rated current
Is %	Current in phase S as percent of the CT rated current
It %	Current in phase T as percent of the CT rated current

Digital signals:

Signal	Explanation
Ir>>	High current setting stage start in phase R
Is>>	High current setting stage start in phase S
It>>	High current setting stage start in phase T
I>>[t]	High current setting stage time-over (trip)
Ir>	Low current setting stage start in phase R
Is>	Low current setting stage start in phase S
It>	Low current setting stage start in phase T
I>[t]	Low current setting stage time-over (trip)

2.1.2 Setting guide

The parameters to be set are described in chapter 2.1.1.2. The following guider refers these parameters by the „Parameter name".

PAV
This is the primary rated current of the CT. This setting is not needed for the protection decision about trip command; the value is used only for scaling the measured values for displaying. The algorithm supposes that the secondary rated CT value is identical to the rated current of the device (1 A or 5 A). In case this is not valid (e.g. 1 A CT supplies a 5 A current input), then the primary rated current must be rescaled according to the rated current of the device.

Pin
Low current setting for the phase fault overcurrent protection, related to the input rated current, calculated in [%].

PInn
High current setting for the phase fault overcurrent protection, related to the input rated current, calculated in [%].

PTInn
Time delay for the high current setting stage (definite time). The parameter is given in [ms]. The time delay must be co-ordinated to the other protection setting on the network. The time delay is defined as an additional time delay, id does not include the calculation time of the algorithm.

PTIn
Time delay for the low current setting stage (definite time). The parameter is given in [ms]. The time delay must be co-ordinated to the other protection setting on the network. The time delay is defined as an additional time delay, id does not include the calculation time of the algorithm.

E_InnEng
The function must be enabled using „PROTLOG" equation (similar example see in Fig. 2-2). The high current setting stage must be enabled individually.

E_InEng
The function must be enabled using „PROTLOG" equation (similar example see in Fig. 2-2). The low current setting stage must be enabled individually.

PMxsInntOnt, PMxsIntOnt
Setting for latching of the high and low current setting stages individually. If latching is set, then the „on" state is kept even if the current drops below the setting level. Resetting is possible with acknowledgement only, if the current drops below the setting value. Acknowledgement must be programmed with PROTLOG equation, as indicated in Fig. 2-22. (See below).

2.1.3 Tests of the overcurrent protection

For testing it is advisable to disable the other protection functions, and the overcurrent protection stages must be enabled using PROTLOG equations (similar examples see in Fig. 2-2).

Before testing check parameter setting, especially the marshalling of the status signals to the relay outputs.

The tests can be performed using a single phase current or with a three-phase test set as well.

The function measures and displays the basic harmonic value of the measured currents. The measured values can be seen on the integrated LCD in the „Test" menu item, or they can be seen on the „On-line" screen of the connected PC, using the „Protect for Windows" software. The algorithm operates with the RMS value of the basic harmonic current component. If the shape of the current is not sinusoid, there can be considerable measured differences between the measured values of an independent measuring instrument and the displayed values. It is advised to use a test set, generating pure sinusoid test currents.

If the current setting is below the continuous overload capability of the input current transformers, the tests can be performed using slowly increasing currents. In case of higher current dynamic test method must be applied. The test current must be switched on the input, and check no operation at 95 % setting values, and no operation at 105 % setting.

To check the time delay it must be considered that the time setting is an additional time delay, it does not include the operation time of the measuring algorithm. This measurement can be performed using currents twice of the current setting.

2.2 Earth-fault zero sequence overcurrent protection

One of the main functions of the complex DTI-MV-EP protection is the earth-fault zero sequence overcurrent protection. The device measures the zero sequence current in two different ways: the zero sequence current is received by an independent analogue input, and the zero sequence current is calculated as the sum of the three phase currents. This function is a two stage definite time overcurrent protection. The earth-fault protection is similar to the phase fault overcurrent protection, but the operation of the low current setting stage – besides the enabling – has some special conditions as well:

- no operation of the phase-fault current stages, and
- if the directionality is enabled then
  - the zero sequence overvoltage function must start too and
  - the phase angle between the zero sequence voltage and the zero sequence current must be between the pre-set limits.

The setting of the directional function needs determination of the lower and upper angle limits and the hysteresis. In case of exact angle measurement requirement the angle correction must be defined as well.

The operation characteristics of the directional function and the meaning of the parameters are drawn on Fig. 2-8.

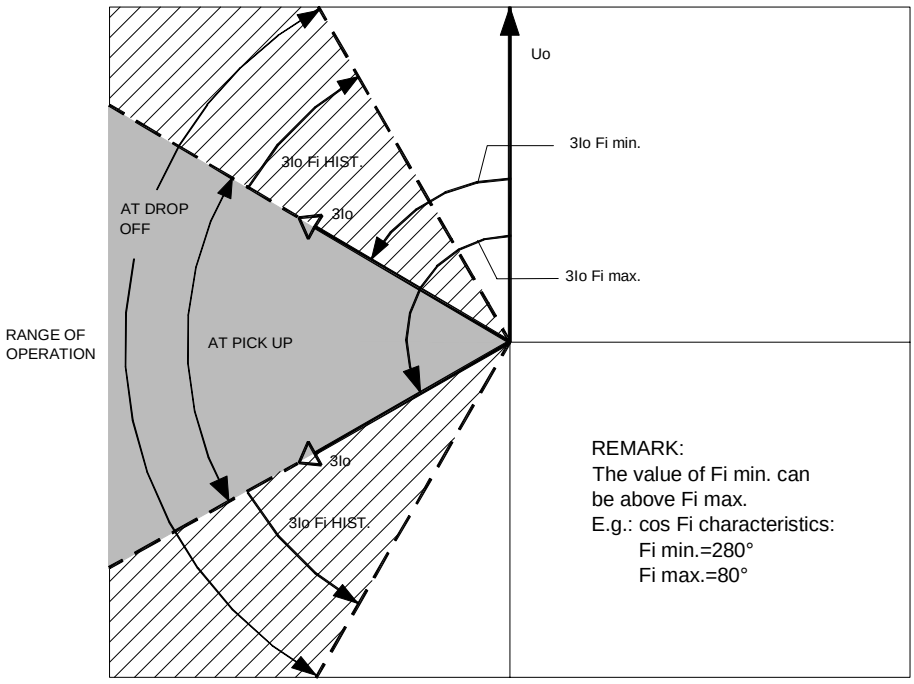

Fig. 2-8.The Fi(UoIo) setting.

The zero sequence high current setting stage does not have directionality, and the only condition of the operation is the enabling.

2.2.1 Zero sequence overcurrent protection – method of operation

The operation of the earth-fault zero sequence overcurrent protection in the DTI-MV-EP factory configuration is independent of the operation of phase-fault stages.

2.2.1.1 Analogue inputs of the function

In one way the function calculates the zero sequence current (3Io) as the sum of the phase currents, in the other way the zero sequence current is received from a core balance CT in a dedicated current input.

Ir+Is+It
Io

In case of directionality the function calculates the sum of the phase voltages:

Ur+Us+Ut

Using Fourier algorithm the program calculates the base harmonic of the zero sequence currents received from both sources. The zero sequence current calculated as the sum of three phase currents is applied by the high current setting stage, the current measured in a dedicated current input sis used by the low current setting stage. At start of both stages the dedicated timers are started. If any of them runs out, the function issues the trip command.

2.2.1.2 The parameter setting

The protection function needs setting of the following parameters:

1.) On the integrated LCD:

Name	LCD	Min	Max	Step	Explanation
PIon	Io>/Ion[CToProt] = %	10	140	1	Setting of the zero sequence low current setting stage, as percent of the rated CT current
PIonn	Io>>/Ion[CTProt] = %	20	2500	5	Setting of the zero sequence high current setting stage, as percent of the rated CT current
PAVo	AvoPrN['CToProt]= A	10	1000	1	The primary rated current of the zero sequence CT reduced to 100 mA, or 500 mA secondary value, used only to scale the displayed values
PUon	Uo>/Un[VTprot]%	10	110	1	Setting of the zero sequence overvoltage function, as percent of the rated voltage of the device
PioUoFi Min	Fi(IoUo) min deg	0	359	1	Lower angle limit
PioUoFi Max	Fi(IoUo) max deg	0	359	1	Upper angle limit
PioUoFi Hiszt	Fi(IoUo) hist deg	0	359	1	Hysteresis of the angle measurement (drop-off ratio of angle decision)
PioUoFi Komp	Fi(IoUo) comp /10 deg	0	3599	1	Angle error compensation
PTIonn	t (Io>>) = ms	0	60000	10	High current setting stage time delay
PTIon	t (Io>) = ms	0	60000	10	Low current setting stage time delay
PTUon	t (Uo>) = ms	0	60000	10	Zero sequence overvoltage stage time delay
E_Ion Eng	(Setting with PROTLOG equation only!)	0	1	1	Enabling of the low current setting stage
E_Ionn Eng	(Setting with PROTLOG equation only!)	0	1	1	Enabling of the high current setting stage
E_IonFi Eng	(Setting with PROTLOG equation only!)	0	1	1	Enabling of the directionality
E_Uon Eng	(Setting with PROTLOG equation only!)	0	1	1	Enabling of the zero sequence overvoltage stage

PMxsIonntOnt	Io>>[t] latching: /+=yes/	-	+		Latching of matrix row for high current setting stage time-over
PMxsIontOnt	Io>[t] latching: /+=yes/	-	+		Latching of matrix row for low current setting stage time-over

2.) Settings of the function on the „On-line" PC screen:

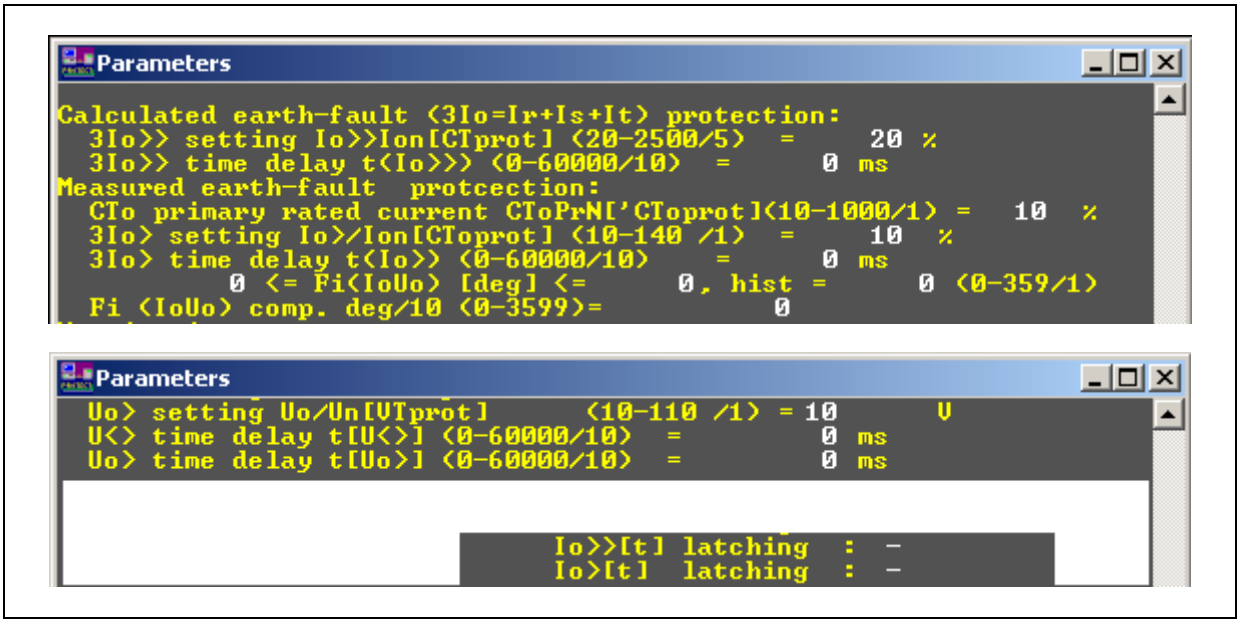

Fig. 2-9. Parameter setting /2

2.2.1.3 Outputs of the protection function

The functions deliver status signals indicating the operation. Among others these will be the inputs (rows) of the software matrix. These inputs can be marshalled with matrix programming to the outputs (columns) of the matrix. The status signals of the functions can be inputs of the „PROTLOG" logic equations as well.

The matrix rows of the zero sequence overcurrent protection function are:

Matrix row	Explanation
Mx 3Io>>	Starting of the high current setting stage
Mx 3Io>	Starting of the low current setting stage
Mx 3Io>>[t]	High current setting stage time-over (trip command)
Mx 3Io>[t]	Low current setting stage time-over (trip command)
Mx Uo>	Starting of the zero sequence overvoltage stage
Mx Uo>[t]	Zero sequence overvoltage stage time-over (trip command)

These signals can be marshalled to the outputs using the software matrix (see similar example in Fig. 2-5.).

2.2.1.4 Inputs of the PROTLOG equations:

Equation inputs	Explanation
Io>>	Start of the high current setting stage
Io>	Start of the low current setting stage
Io>>[t]	High current setting stage time-over (trip command)
Io>[t]	Low current setting stage time-over (trip command)
Uo>	Start of the zero sequence overvoltage stage
Uo[t]	Zero sequence overvoltage stage time-over (trip command)

2.2.1.5 The displayed information

As a secondary product of the function the following information can be displayed on the integrated LDC of the device or on the PC screen:

Displayed information on the LCD using „*Test*" menu item:

Measured analogue values:

LCD	Explanation
IoMeasured [A]=	Zero sequence current as measured on the dedicated input
IoCalculated[A]=	Zero sequence current calculated as the sum of the three phase currents
Uosecondary[V]=	The zero sequence voltage secondary value calculated as the sum of the three phase voltages

Displayed status signals on the PC screen:

Signal	Explanation
Io>>Enabled	High current setting stage enabling
Io> Enabled	Low current setting stage enabling
IoFi> Enabled	Directional function enabling
Io>> start	Starting of the high current setting stage
Io> start	Starting of the low current setting stage
Io>>[t]timeout	High current setting stage time-over (trip command)
Io>[t]timeout	Low current setting stage time-over (trip command)

The displayed information on the „On-line" PC screen of the Protect for Windows software (information concerning other protection functions is masked):

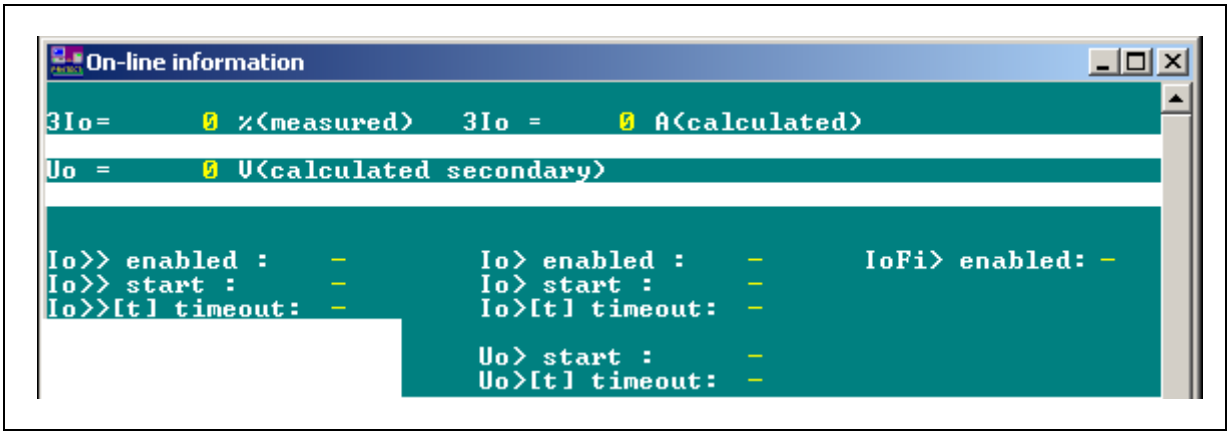

Fig. 2-10. On-line data /2

The enabled state is indicated by a „+" character, for the overcurrent stages a „+" character indicates starting or trip signal after time-over.

2.2.1.6 Messages of the function

There is only one message related to the function:

```
Trip command!
```

To enable this message a „PROTLOG" logic equation must be composed for the „`Trip command`" logic variable. Fig. 2-5 sows an example.

2.2.1.7 Event recording

The event recording function record the following events with time stamp, as displayed on the integrated LCD:

```
Io>> start
Io>  start
Io>[t]  timeout
Io>>[t] timeout
Uo>  start
Uo>[t]  timeout
Uo>>[t] timeout
```

2.2.1.8 Evaluated events

The dedicated PC window displays the related information as show non Fig. 2-11. (The information related to other functions is masked):

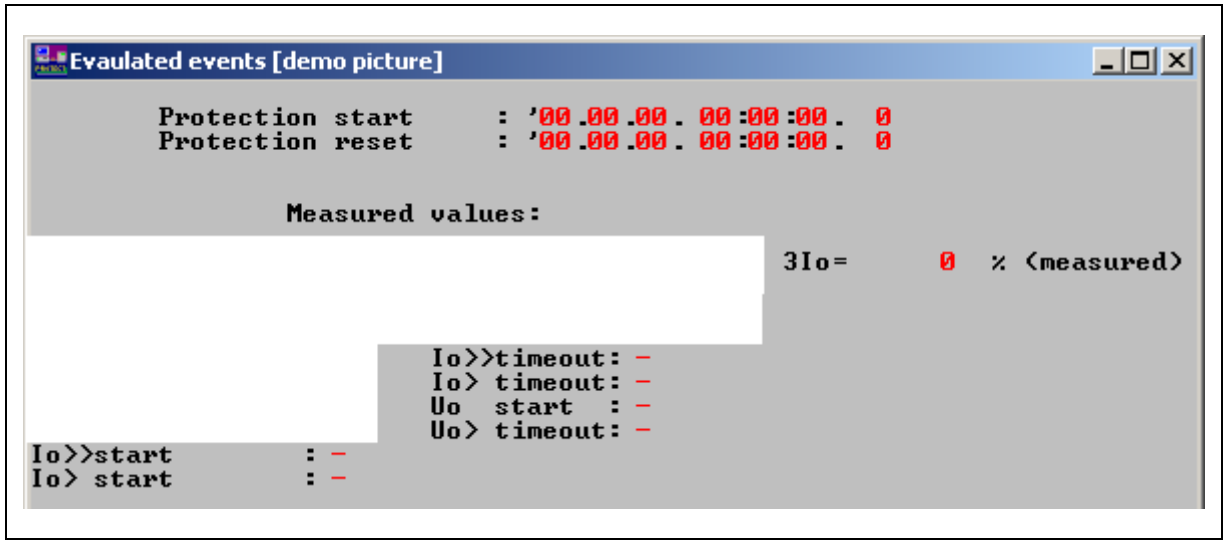

Fig. 2-11. Evaluated events /2

2.2.1.9 Counters

This protection function operates the following counters (as displayed on the integrated LCD):

```
Io>>[t]   Counter:
Io> [t]   Counter:
Uo> [t]   Counter:
```

This information is displayed on the „On-line" PC screen as shown on Fig. 2-12.:

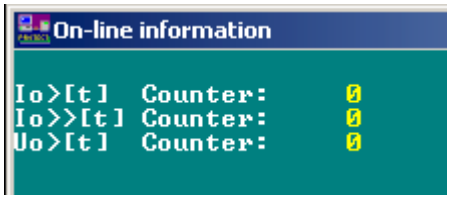

Fig. 2-12. Counters /2

2.2.1.10 LED indication

The operation of the functions integrated into the device is indicated by seven LED-s located on the front panel. The LED-s shown in the following table are related to the zero sequence overcurrent protection (LEDs are numbered from top to bottom):

LED No.	LED text	Explanation
8	3Io>	Zero sequence overcurrent protection operated

2.2.1.11 Signals recorded in the disturbance recorder

This function generates the following information for the integrated disturbance recorder:

Analogue signals:

Signal	Explanation
Io %	Measured zero sequence current as percent of the CT rated current

Digital signals:

Signal	Explanation
Io>>	Starting of the high current setting stage
Io>>[t]	High current setting stage time-over (trip command)
Io>	Starting of the low current setting stage
Io>[t]	Low current setting stage time-over (trip command)
Uo>	Starting of the zero sequence overvoltage function
Uo>[t]	Zero sequence overvoltage function time-over (trip command)

2.2.2 Setting guide for the zero sequence overcurrent function

The parameters to be set are described in chapter 2.2.1.2. The following guide refers to the parameters by the „Parameter name".

Pion
Setting value of the low current setting stage related to the CT rated current. The value is expressed in percent [%].

Pionn
Setting value of the high current setting stage related to the CT rated current. The value is expressed in percent [%].

PAVo
The primary rated current of the dedicated zero sequence CT. This setting is not used by the protection function for protection decision; it is needed only for scaling the displayed measured value. The algorithm assumes that the secondary rated current of the CT is identical with that of the device (100 mA, 1A or 5 A). If the values are different than the primary value must be related to the rated current of the device.

Puon
Setting value of the zero sequence overvoltage protection function, related to the rated input voltage of the device. The parameter is expressed in percent [%].

PioUoFiMin
PioUoFiMax
Lower and upper angle limit of the directional zero sequence earth-fault overcurrent protection. The angles are expressed in degrees. The setting range is 0 … 359°. (Negative angles can not be set.) The limits are explained in Fig. 2-8. The numerical value of the „FiMin" angle can be above the „FiMax" value. For example the realisation of a „cos Fi" function the possible setting can be „FiMin=280°", „FiMax=80°"

PioUoFiHiszt
After starting the angle range of the function „opens" according to the hysteresis value expressed in degrees (angle drop-off ratio). See Fig 2-8.

PioUoFiKomp
With this parameter the angle errors of the VT and CT can be compensated. The meaning of this angle value is as follows: the VT angle error is subtracted from the CT angle error, and the compensating angle setting is the negative value of the subtraction.

PTIonn
Time delay for the high current setting stage.

PTIon
Time delay for the low current setting stage.

PTUon
Time delay for the zero sequence overvoltage function.

E_IonEng
E_IonnEng
E_IonFiEng
E_UonEng
The individual functions, the sequence above is: zero sequence low current setting stage, zero sequence high current setting stage, zero sequence directionality, and zero sequence overvoltage function, must be enabled separately. To enable the functions PROTLOG equations must be composed (see Fig. 2-22.). The programming method of the PROTLOG equations is described in „EuroProt" *EPCP-2004* manual.

PmxsIonntOnt
PmxsIontOnt
These parameters set the latching of the high set and low set zero sequence overcurrent protection command outputs to the appropriate matrix rows. If the setting is „+", which means that latching is set, then the signal value „1" does not reset after the disappearing of

the overcurrent state until acknowledgement. The acknowledgement is to be programmed with PROTLOG equation. An example is shown on Fig. 2-22. (See below).

2.2.3 Checking the earth-fault overcurrent protection

For checking this function all other functions are advised to be disabled.

When checking the low current setting zero sequence protection, take the fact into consideration, that there are other special conditions to be fulfilled as well:

- the zero sequence current is measured in the dedicated current input,
- the phase overcurrent protection function may not operate, and
- if the directionality is enabled, then the zero sequence overvoltage function must operate as well (in order to avoid wrong operation because of too low voltage value), so this function must be enabled as wee, and the angle between the voltage and current must be between the limits as well.

The high current setting stage must be enabled, and the zero sequence current is calculated as the sum of the three phase currents. .

For both stages the trip signals of the functions must be marshalled to the appropriate relay output(s) using the software matrix.

The protection function measures and displays the basic harmonic of the zero sequence current. This value can be seen in the integrated LCD using the „Test" menu item, or on the „On-line" screen of the connected PC using the Protect for Windows software. The algorithm operates with the RMS value of the basic harmonic current component. If the shape of the current is not sinusoid, there can be considerable measured differences between the measured values of an independent measuring instrument and the displayed values. It is advised to use a test set, generating pure sinusoid test currents.

If the current setting is below the continuous overload capability of the input current transformers, the tests can be performed using slowly increasing currents. In case of higher current dynamic test method must be applied. The test current must be switched on the input, and check no operation at 95 % setting values, and no operation at 105 % setting.

To check the time delay it must be considered that the time setting is an additional time delay, it does not include the operation time of the measuring algorithm. This measurement can be performed using currents twice of the current setting.

2.3 Zero sequence overvoltage function

The integrated zero sequence overvoltage function is an integral part of the directional zero sequence overcurrent protection, but it can be applied as an independent function as well. See details in chapter 2.2. in connection with the directional zero sequence overcurrent protection.

2.4 Phase overvoltage and undervoltage function

If the device contains voltage input module, then the algorithm measures the three phase voltages, and calculates the three line-to-line voltages. For these voltages the basic harmonic Fourier component is calculated, which are the basis of over- or undervoltage comparison. The signal of over- or undervolage can be issued based on a single voltage only, or the signal can be sent, if at least two voltages are violating the setting for the limit.

2.4.1 Method of operation

This function operates in the DTI-MV-EP factory configuration independently of the other protection functions.

2.4.1.1 Analogue inputs of the function

The analogue inputs of the functions are the three phase voltages:

```
Ur
Us
Ut
```

Based of the phase voltages the line-to-line voltages `(Urs, Ust, Utr)` are calculated, and then using Fourier method, the basic harmonics are determined. This method eliminates the zero sequence voltage caused by the neutral point displacement, and the higher harmonics.

2.4.1.2 Parameter setting

This function needs setting of the following parameters:

Name	LCD	Min	Max	Step	Explanation
PUnk	U<>/Un[VTprot]= [%]	10	110	1	Setting of the function related of the rated input voltage of the device.
PUnkIrany	U<> type = [0=U>]	0	1	1	Definition of under- or overvoltage measurement
PFV	FVPrn['VTprot]: V	100	32000	10	VT primary rated voltage. If the VT rated secondary voltage is not identical with that of the device then the primary rated voltage must be referred to the rated voltage of the device. (100 V or 200 V)
PTUnk	t[U<>] = ms	0	60000	1	Time delay setting
PU32	U<>3/2 logic /+=yes/				„+=yes" means that at least two of the three line-to- line voltages must violate the setting „-=no" means that one voltage violating the limit causes signal of the function.
E_UnkEng	(Can be set by PROTLOG equation only!)	0	1	1	Enabling of the function

Setting values as displayed on the PC screen using the Protect for Windows software is show non Fig. 2-13. (Information related to other function is masked):

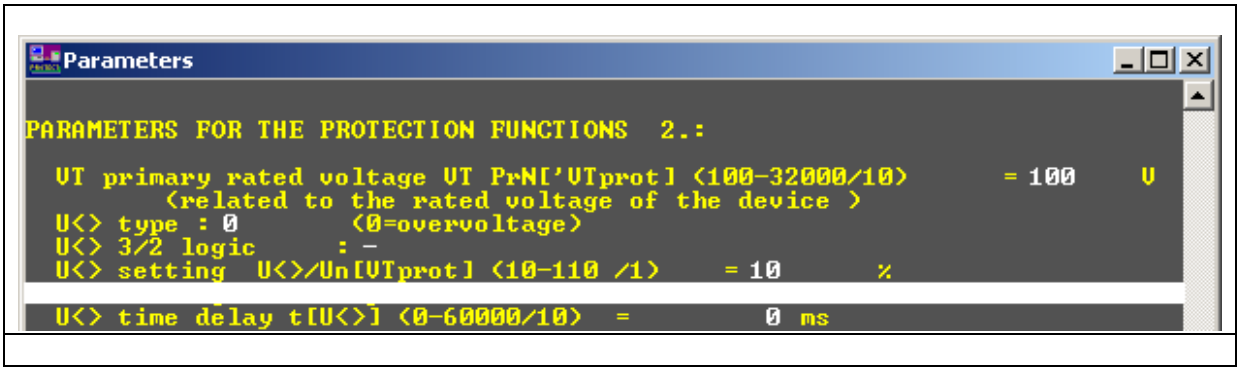
Parameters
PARAMETERS FOR THE PROTECTION FUNCTIONS 2.:
VT primary rated voltage VT PrN['VTprot] (100-32000/10) = 100 V
(related to the rated voltage of the device)
U<> type : 0 (0=overvoltage)
U<> 3/2 logic : -
U<> setting U<>/Un[VTprot] (10-110 /1) = 10 %
U<> time delay t[U<>] (0-60000/10) = 0 ms

Fig. 2-13. Parameter setting /3

2.4.1.3 Outputs of the function

The functions deliver status signals indicating the operation. Among others these will be the inputs (rows) of the software matrix. These inputs can be marshalled with matrix programming to the outputs (columns) of the matrix. The status signals of the functions can be inputs of the „PROTLOG" logic equations as well.

The matrix rows of the phase overcurrent protection function are:

Matrix row	Explanation
Mx U<>	Staring of the over / undervoltage function
Mx U<>[t]	Over / undervoltage function time-over (trip signal)

These signals can be marshalled to the outputs using the software matrix (see similar example in Fig. 2-5.).

2.4.1.4 Inputs of the PROTLOG equations:

Input	Explanation
U<> start	Staring of the over / undervoltage function
U<>[t]timeout	Over / undervoltage function time-over (trip signal)

2.4.1.5 The displayed information

As a secondary product of the function the following information can be displayed on the integrated LDC of the device or on the PC screen:

Displayed information on the LCD using „*Test*" menu item:

Measured analogue values:

LCD	Explanation
Urs[V] =	RS line-to-line voltage Fourier base harmonic
Ust[V] =	ST line-to-line voltage Fourier base harmonic
Utr[V] =	TR line-to-line voltage Fourier base harmonic

Displayed status signals on the PC screen:

Signal	Explanation
U<> Enabled :	Function enabled
Urs<> start:	RS line-to-line voltage limit violation
Ust<> start:	ST line-to-line voltage limit violation
Utr<> start:	TR line-to-line voltage limit violation
U<>[t]timeout :	Over / undervoltage function time-over

The displayed information on the „On-line" PC screen of the Protect for Windows software (information concerning other protection functions is masked):

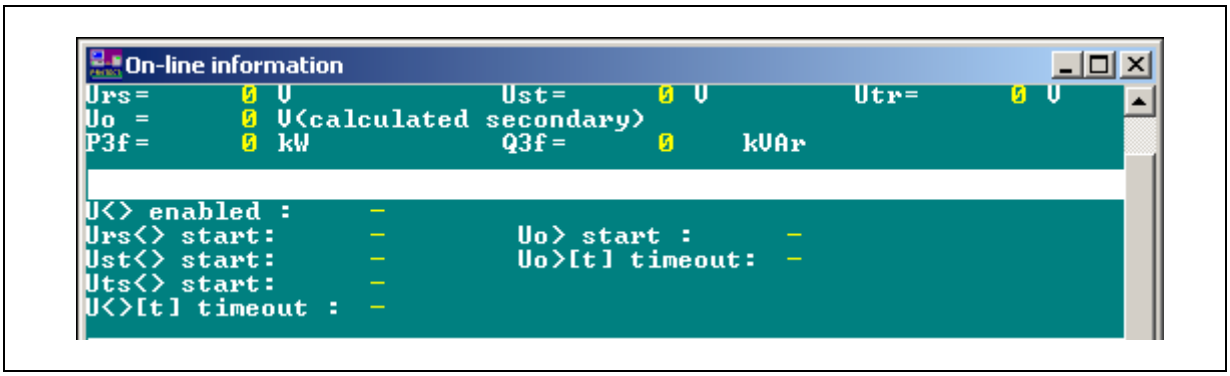
On-line information
Urs= 0 V Ust= 0 V Utr= 0 V
Uo = 0 V(calculated secondary)
P3f= 0 kW Q3f= 0 kVAr
U<> enabled : -
Urs<> start: - Uo> start : -
Ust<> start: - Uo>[t] timeout: -
Uts<> start: -
U<>[t] timeout : -

Fig. 2-14. On-line data /3

The enabled state is indicated by a „+" character, for the over/undervoltage function a „+" character indicates starting or trip signal after time-over.

The measured voltages and currents allow power measurement as well:

LCD	Explanation
P3F [kW]	Calculated three-phase active power
Q3F [kvar]	Calculated three-phase reactive power

This information is displayed on the PC screen as follows:

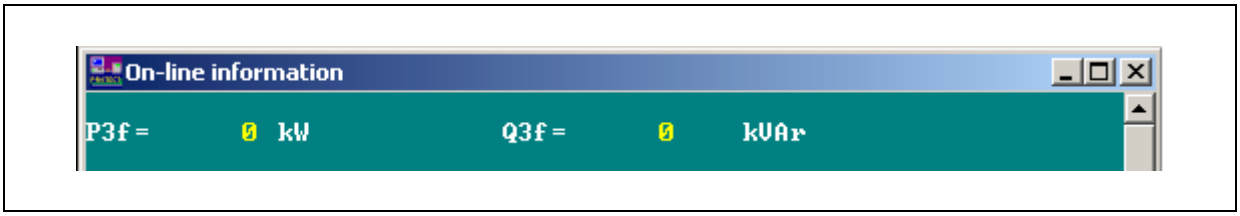

Fig. 2-15. On-line data 4

2.4.1.6 Message of the function

There is only one message related to the function:

```
Trip command!
```

To enable this message a „PROTLOG" logic equation must be composed for the „`Trip command`" logic variable. Fig. 2-5 sows an example.

2.4.1.7 Event recording

The event recording function record the following events with time stamp, as displayed on the integrated LCD:

```
Urs<> start
Ust<> start
Utr<> start
U<>[t] timeout
```

2.4.1.8 Evaluated events

The dedicated PC window displays the related information as show non Fig. 2-16. (The information related to other functions is masked):

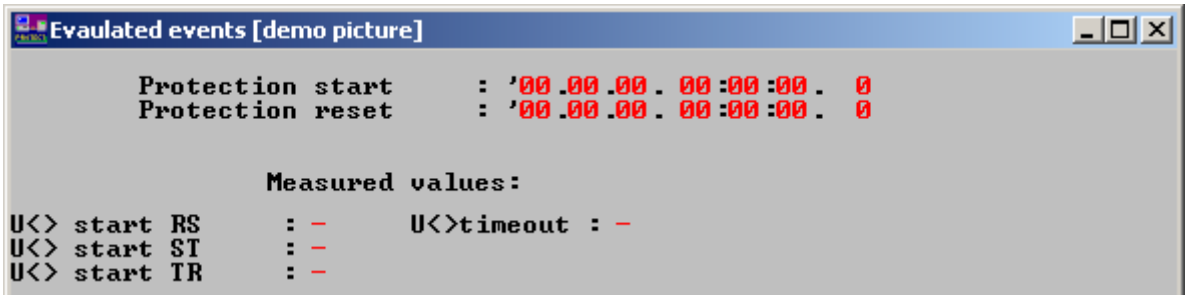
Evaulated events [demo picture]
Protection start : '00.00.00. 00:00:00. 0
Protection reset : '00.00.00. 00:00:00. 0
Measured values:
U<> start RS : - U<>timeout : -
U<> start ST : -
U<> start TR : -

Fig. 2-16.Evaluated events /3

2.4.1.9 Counters

The counter related to this function is:

```
U<> [t] counter:
```

This information is displayed on the „On-line" PC screen as shown on Fig. 2-17.:

Fig. 2-17.Counters /3

2.4.1.10 LED signals

None of the seven integrated LEDs give signal related to this function.

2.4.1.11 Information on the disturbance recorder

This function generates the following information for the integrated disturbance recorder:

Analogue signals:

Signal	Explanation
Ur	Phase R voltage, primary value
Us	Phase S voltage, primary value
Ut	Phase T voltage, primary value

Digital signals of the over/undervoltage function:

Signal	Explanation
Urs<>	Starting of the function for RS line-to line voltage
Ust<>	Starting of the function for ST line-to line voltage
Utr<>	Starting of the function for TR line-to line voltage
U<>[t]	Function time-over

2.4.2 Setting guide for the over/undervoltage function

The parameters to be set era described in chapter 2.4.1.2. The following guide refers to the parameters by the „parameter name".

Punk
Function setting related to the rated input voltage (100 V or 200 V).

PunkIrany
Definition of under- or overvoltage measurement. In case of overvoltage function the value to be set is „0", for undervoltage function it is „1".

PFV
VT primary rated voltage. If the VT rated secondary voltage (e.g. 110 V or 220 V) is not identical with that of the device then the primary rated voltage must be referred to the rated voltage of the device (100 V or 200 V). For example for a VT rated 11000/110 V connected to a 100 V rated device input then the value to be set is „10000".

PTUnk

Time delay for the function.

PU32
Setting of the 3/2 logic. „+=yes" means that at least two of the three line-to- line voltages must violate the setting. „- =no" means that one voltage violating the limit causes signal of the function.

2.4.3 Testing the over/undervoltage function

For the tests all other functions must be disabled.

In the tests the fact must be considered that the pre-condition for the operation of the over/undervoltage function is the enabled state (as defined by PROTLOG equation). The trip signal must be marshalled with matrix programming to the appropriate output relay.

The protection function measures and displays the calculated base harmonic values of the line-to-line voltages. These values can be red on the integrated LCD on the front panel of the device using the „*Test*" menu item. This information is shown on the On-line screen of the PC as well using the Protect for Windows software. The algorithm operates with the RMS value of the basic harmonic voltage component. If the shape of the voltage is not sinusoid, there can be considerable measured differences between the measured values of an independent measuring instrument and the displayed values. It is advised to use a test set, generating pure sinusoid test voltages.

If the current setting is below the continuous overload capability of the input voltage transformers, the tests can be performed using slowly increasing (or decreasing) voltages. In case of higher voltage dynamic test method must be applied. The test voltage must rapidly increase, and check no operation at 95 % setting value, and operation at 105 % setting.

To check the time delay it must be considered that the time setting is an additional time delay, it does not include the operation time of the measuring algorithm. Use at least 20% higher (or lower) value than the setting for the tests.

2.5 Additional implemented functions

2.5.1 Integrated tripping matrix

The software matrix marshals the generated signals of the protection functions or the results of the PROTLOG equations to the output relays of the device or to the starting inputs of the free programmable timers. The inputs are the matrix rows, the output possibilities are the matrix columns.

2.5.1.1 The inputs of the matrix

The inputs of the matrix are the activating protection functions; they are arranged to the rows of the matrix:

Matrix row	Explanation
Mx I(rst)>> =	Start of high current setting phase overcurrent protection.
Mx I(rst)> =	Start of low current setting phase overcurrent protection.
Mx 3Io>> =	Start of high current setting zero sequence overcurrent protection.
Mx 3Io> =	Start of low current setting zero sequence overcurrent protection.
Mx I(rst)>>[t] =	Trip command of high current setting phase overcurrent protection.
Mx I(rst)>[t] =	Trip command of low current setting phase overcurrent protection.
Mx 3Io>>[t] =	Trip command of high current setting zero sequence overcurrent protection (time over).
Mx 3Io>[t] =	Trip command of low current setting zero sequence overcurrent protection (time over).
Mx Uo> =	Start of zero sequence overvoltage protection.
Mx Uo>[t] =	Trip command of zero sequence overvoltage protection(time over).
Mx U<> =	Start of over/undervoltage protection.
Mx U<>[t] =	Trip command of over/undervoltage protection.
Mx Timer 1 over =	Time-over of 1st free programmable timer.
Mx Timer 2 over =	Time-over of 2nd free programmable timer.
Mx CHK OK =	Self-check: no errors detected
Mx Equation 1:	Output of free programmable 1st logic equation.
Mx Equation 2:	Output of free programmable 2nd logic equation.
Mx Equation 3:	Output of free programmable 3rd logic equation.
Mx Equation 4:	Output of free programmable 4th logic equation.
Mx Equation 5:	Output of free programmable 5th logic equation.
Mx Equation 6:	Output of free programmable 6th logic equation.
Mx CB OFF =	CB ON control command from the „Control" window
Mx CB ON =	CB OFF control command from the „Control" window

2.5.1.2 The outputs of the matrix

The matrix columns are the possible outputs of the matrix. They include the first 8 relay outputs and the starting inputs of the two free programmable timers.

2.5.1.3 Programming the tripping matrix

The programming is very convenient with an external PC, using Protect for Windows software (see „*EPCP-2004*" documentation), but the man-machine interface of the device offers possibility to programming as well.

a.) Programming of the tripping matrix using Protect for Windows software's „*Parameters*" window:

The assignment of the inputs and outputs of the tripping matrix is easy: the intersection of the appropriate row and column must be marked with a „+" character.

Fig. 2-18 shows the initial state of the matrix with no assignments:

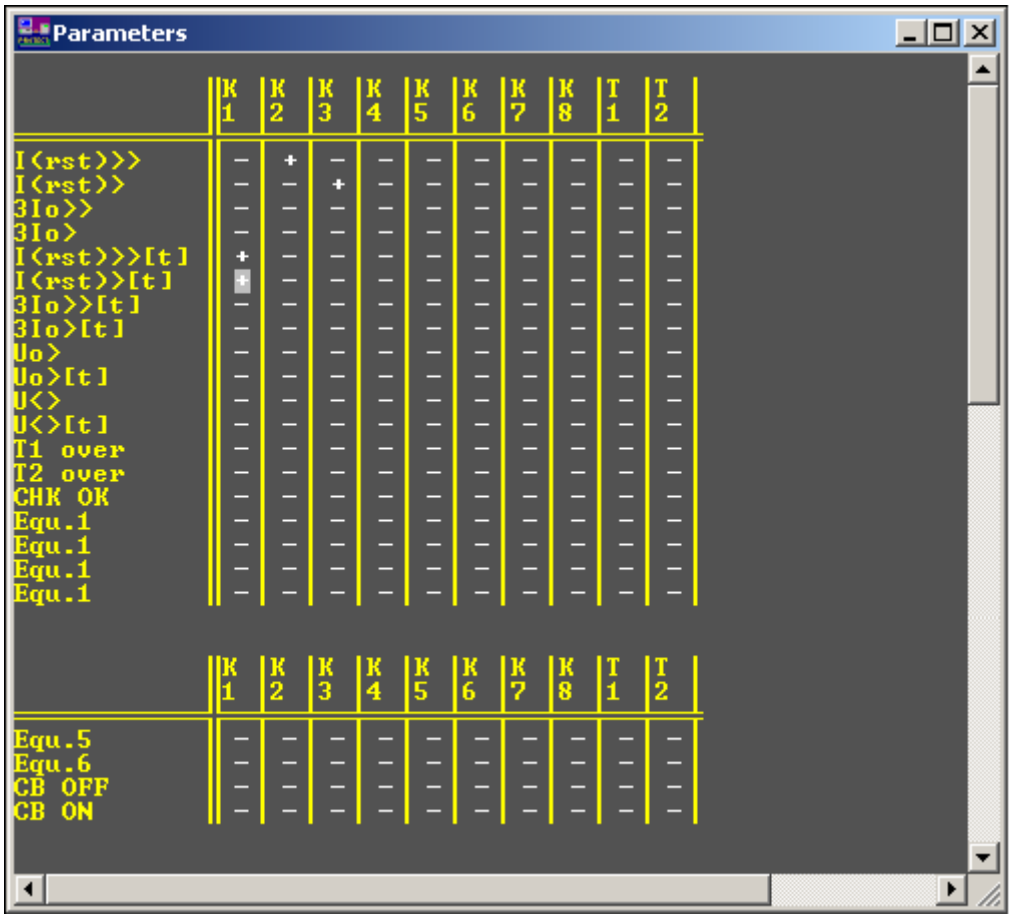

Fig. 2-18. The tripping matrix

b.) Programming of the tripping matrix using the man-machine interface of the device:

If the parameters are to be set using the man-machine interface of the device, then the parameters of the matrix rows are to be calculated as the hexadecimal sum of the selected outputs of the matrix. The hexadecimal code values of the columns are as follows:

Matrix column	Hexadecimal code
K1 output relay	2^0 = 1h,
K2 output relay	2^1 = 2h,
K3 output relay	2^2 = 4h,
K4 output relay	2^3 = 8h,
K5 output relay	2^4 = 10h,
K6 output relay	2^5 = 20h,
K7 output relay	2^6 = 40h,
K8 output relay	2^7 = 80h,
T1. timer start	2^8 = 100h,
T2. . timer start	2^9 = 200h,

2.5.2 The PROTLOG equations

The available digital status signals are the input possibilities of the PROTLOG equation system, which can be „freely" programmed to set output variables of the equation system.

2.5.2.1 Inputs of the logic equations

The available inputs for the logic equations are listed in the following table:

Input	Explanation
`Input1-Input16`	Status signal of the first 16 opto-coupler digital inputs of the device
`K1-K8`	Status signal of the first 8 relay outputs of the device
`Ir>>,Is>>,It>>`	Starting of the high current setting phase overcurrent function in the indicated phase
`Ir> Is> It>`	Starting of the low current setting phase overcurrent function in the indicated phase
`I>>[t]`	Time-over of the high current setting phase overcurrent function
`I>[t]`	Time-over of the low current setting phase overcurrent function
`Io>>`	Starting of the high current setting zero sequence overcurrent function
`Io>>[t]`	Time-over of the high current setting zero sequence overcurrent function
`Io>`	Starting of the low current setting zero sequence overcurrent function

Io>[t]	Time-over of the low current setting zero sequence overcurrent function
t[T1]timeout	Time-over of the 1st free programmable timer
t[T2]timeout	Time-over of the 2nd free programmable timer
1.CB circ OK	Status signal of the trip circuit supervision unit (see „*EPCP-2004*")
2.CB circ OK	Status signal of the trip circuit supervision unit (see „*EPCP-2004*")
3.CB circ OK	Status signal of the trip circuit supervision unit (see „*EPCP-2004*")
4.CB circ OK	Status signal of the trip circuit supervision unit (see „*EPCP-2004*")
SW1	SW1 switch on the front panel is pressed
SW2	SW2 switch on the front panel is pressed
Prot start	Start of the analogue event recorder
U<>start	Start of the over/undervoltage function
U<>[t]timeout	Time-over of the over/undervoltage function
Uo>start	Start of the zero sequence overvoltage function
Uo>[t]timeout	Time-over of the zero sequence overvoltage function
CHK5,6,7,8	Status signal of the supervision unit (see „*EPCP-2004*")

The inputs on the PC screen, marked with „*" character are latched status signals.

2.5.2.2 Outputs of the logic equations

Output	Explanation
Matrix equation 1-6	Outputs of the 1 - 6 PROTLOG equations, which are matrix row elements
K9-K16	Status signals directed to relay outputs K9 – K16
I>>Enabled	Enabling signal for the high current setting phase overcurrent protection function
I>Enabled	Enabling signal for the low current setting phase overcurrent protection function
Io>>Enabled	Enabling signal for the high current setting zero sequence overcurrent protection function
Io>Enabled	Enabling signal for the low current setting zero sequence overcurrent protection function
E_IonFiEng	Enabling signal for the directionality of low current setting zero sequence overcurrent protection function
E_U<>Enabled	Enabling signal for the phase over/undervoltage function
E_Uo>Enabled	Enabling signal for the zero sequence overvoltage function
Acknowledgement	Acknowledgement
t[CBcirc.error] start	Time delay for CB circuit error signal
Trip command	Triggering signal for the event recorder
Dist rec. level trig	Level triggering for the disturbance recorder
Dist rec. edge trig	Edge triggering for the disturbance recorder

trig	

2.5.2.3 Programming the PROTLOG equations

The PROTLOG equations can be programmed with the connected PC only, using Protect for Windows software. The method of programming is a graphical method, described in „*EPCU-2004*" documentation. (The man-machine interface of the device does not support PROTLOG programming).

2.5.3 Application of signals from the digital inputs

Depending on the hardware configuration the device provides 0/8/16/24/32 digital inputs. Out of the first 16 inputs are assigned to the protection part of the software as inputs of the PROTLOG equations. The main protection functions do not test these inputs directly. In order to apply these inputs (2x8 optical digital interfaces) the modules must be enabled with parameter setting.

The parameters to be set are:

Name	LCD	Min	Max	Step	Explanation
O1ModuleEng	Opto module 1? /+=yes/	-	+		Enabling the first module, containing digital inputs No. 1-8
O2moduleEng	Opto module q? /+=yes/	-	+		Enabling the second module, containing digital inputs No. 9-16

This setting is displayed on the „On-line" screen of the Protect for Windows software:

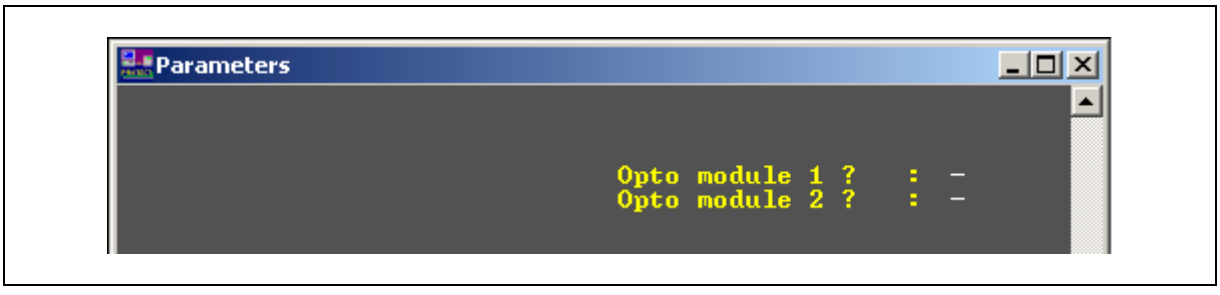

Fig. 2-19. Parameter setting /4

In order to save memory for longer records, the integrated disturbance recorder function records the status of inputs No. 1-8 only.

The supervisory and control functions implemented in the device can use all digital inputs.

If the device includes the optional output circuit supervision module, (see EPCP-2004) there, are four additional inputs for free application.

2.5.3.1 Setting guide

The parameters to be set are described in chapter 2.5.3. The following guide refers to this parameter by the „Parameter name".

```
O1ModuleEng
O2ModuleEng
```

If the device contains optional digital input modules, they must be enabled by parameter setting. If they are not enabled, the changes on the inputs will not be detected by the algorithm. The enabling is allowed only if the input modules are available. The faulty setting will cause errors in operation.

2.5.4 Application of output relays

Depending on the hardware configuration there can be 8/16/24 output relays available. Out of the protection functions can drive the relays No. 1-8 only. The status signals of the protection functions are marshalled using tripping matrix (see Fig. 2-3.).

The status of the relays No. 1-8 is inputs for the PROTLOG equations as well.

Relays No. 9-16 can be programmed using PROTLOG equations.

The optional relay module (module No. 3) with relays No. 17-24 can be driven by the supervisory and control functions only. The output relays No. 1-16 can be assigned individually to the supervisory and control functions. This assignment can be programmed with parameters:

Name	LCD	Min	Max	Step	Explanation
K(i)for SCADA	K(i) for SCADA /+=yes/	-	+		Assignment of relay No. K(i) (i=1-16) to the supervisory and control functions.

This setting is displayed on the „On-line" screen of the Protect for Windows software according to Fig. 2-20:

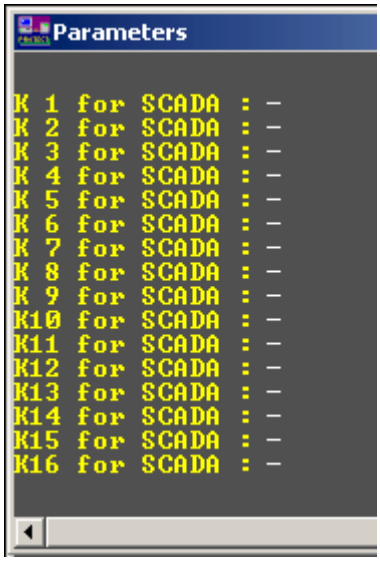
Parameters
K 1 for SCADA : -
K 2 for SCADA : -
K 3 for SCADA : -
K 4 for SCADA : -
K 5 for SCADA : -
K 6 for SCADA : -
K 7 for SCADA : -
K 8 for SCADA : -
K 9 for SCADA : -
K10 for SCADA : -
K11 for SCADA : -
K12 for SCADA : -
K13 for SCADA : -
K14 for SCADA : -
K15 for SCADA : -
K16 for SCADA : -

Fig.2-20. Parameter setting /5

In order to save memory for longer records, the integrated disturbance recorder function records the status of outputs No. 1-4 only.

2.5.4.1 Setting guide

The parameters to be set are described in chapter2.5.4. .The following guide refers to these parameter by the „Parameter name".

`K(i)for SCADA`

If a relay output is assigned to the supervisory and control functions (i.e. setting is „+"), then the protection functions can not influence the status of these relays, even if they are programmed by PROTLOG equations.

2.5.5 Circuit breaker control function

A dedicated window of „Protect for Windows" software is prepared to initiate switching commands to the circuit breaker. This window is displayed on the PC screen according to Fig. 2-21.:

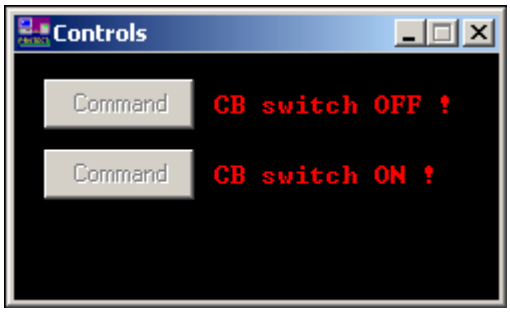

Fig. 2-21. Window for CB control

Both switching commands start a 300 ms timer. During runtime of these timers the input variables `CB_ON` and `CB_OFF` of the tripping matrix are in „1" logic state. These can be directed to any contacts of No.1-8, (or to the free programmable timers). The duration of the control command is the running time of the timer.

2.5.6 The disturbance recorder function

The CPU module includes a simplified disturbance recorder function. In the ***DTI-MV-EP*** device the disturbance recorder handles the sampled analogue data and the status signals. This function has not a man-machine interface; it can communicate only with a PC via fibre optic connection. The records can be analysed on the PC screen, cab be sent to a central engineering workstation or can be printed as well.

The summary of the analogue signals sent to the disturbance recorder function:

Signal	Explanation
`Ir (%)`	R phase current, expressed as a percentage of the rated current
`Is (%)`	S phase current, expressed as a percentage of the rated current
`It (%)`	T phase current, expressed as a percentage of the rated current
`3Io (%)`	The measured zero sequence current expressed as a percentage of the rated current
`Ur (%)`	R phase voltage, expressed as a percentage of the rated voltage
`Us (%)`	S phase voltage, expressed as a percentage of the rated voltage
`Ut (%)`	T phase voltage, expressed as a percentage of the rated voltage

Summary of the status signals sent to the disturbance recorder function:

Signal	Explanation
Ir> Is> It>	Starting of the low current setting stage of the phase overcurrent function, individually in the phases
Ir>> Is>> It>>	Starting of the high current setting stage of the phase overcurrent function, individually in the phases
Io>	Starting of the low current setting stage of the zero sequence overcurrent function
Io>>	Starting of the high current setting stage of the zero sequence overcurrent function
I>[t]	Phase overcurrent function low current setting stage time-over
I>>[t]	Phase overcurrent function high current setting stage time-over
Io>[t]	Zero sequence overcurrent function low current setting stage time-over
Io>>[t]	Zero sequence overcurrent function high current setting stage time-over
Uo>	Starting of the zero sequence overvoltage function
Uo>[t]	Zero sequence overvoltage function time-over
Urs<> Ust<> Utr<>	Starting of the line-to-line over/undervolatge function
U<>[t]	Line-to-line over/undervolatge function time-over
Inp.1 … 8	Status signals of digital inputs 1-8
K1 ... K4	Status signals of digital outputs 1-4

The disturbance recorder function operates with factory settings. For the user the only possibility for interaction is to write logic equation for the triggering with the Protect for Windows program (see „*EPCP-2004*").

As an option the device can be extended with a separate disturbance recorder module. For this module the user can configure the trigger signal (level or edge triggering), timers, names and scales for the individual channels, etc. The record of this disturbance recorder module can be analysed wit an external PC

The optional inputs of the device can be used for any signals.

2.5.7 The free programmable timers

The program of the device provides two free programmable timers. The time delay of these timers can be set with parameters, the starting condition can be programmed in the tripping matrix. In case of time-over the timers send signals to the dedicated inputs of the tripping matrix, which can be marshalled to a relay output, and they are inputs for the PROTLOG equations as well.

2.5.7.1 The parameter setting

Name	LCD	Min	Max	Step	Explanation
PTMXOT1	t(MXO 1.tart) = ms	0	60000	10	Timer with 10 ms accuracy
PTMXOT2	t(MXO 2. tart.) s	0	600	1	Timer with 1 s accuracy

2.5.7.2 Inputs of the timers

The timer starting is to be programmed in the tripping matrix by marking with „+" character the appropriate T1 or T2 column elements (in case of multiple marking the OR connection is valid).

2.5.7.3 Outputs of the timers

The timers send status signals concerning the operation, these can be programmed in the tripping matrix to the output relays, or they can be processed with „PROTLOG" equations.

The matrix rows:

Matrix row	Explanation
Mx Timer 1 over	Timer No. 1 time-over
Mx Timer 1 over	Timer No. 2 time-over

The inputs of the PROTLOG equations:

Input	Explanation
t[T1]timeout	Timer No. 1 time-over
t[T2]timeout	Timer No. 2 time-over

2.5.8 The LED signals

If any of the protective functions operate, the integrated LED-s on the front panel give quick information about the event. As a summary the following table shows the LED assignment for the DTI-MV-EP device:

Name	Explanation
LCD	Warning LED: active if a message is displayed on the LCD, or in case of parameter changes an acknowledgement is needed
CHK	Self check error signal,
L_R	R phase fault,
L_S	S phase fault,
L_T	T phase fault,
L_I>>	High current setting overcurrent stage trip,
L_I>	Low current setting overcurrent stage trip,
L_Io	Zero sequence overcurrent protection trips.

LED-s can be programmed for latching. In this case the signal is kept until acknowledgement after disappearing of the triggering Acknowledgement is to be programmed with a PROTLOG equation.

As an example Fig. 2-22 shows acknowledgement by a signal on Input 8 (remote acknowledgement) or by pressing the SW1 pushbutton on the front panel of the device.

.

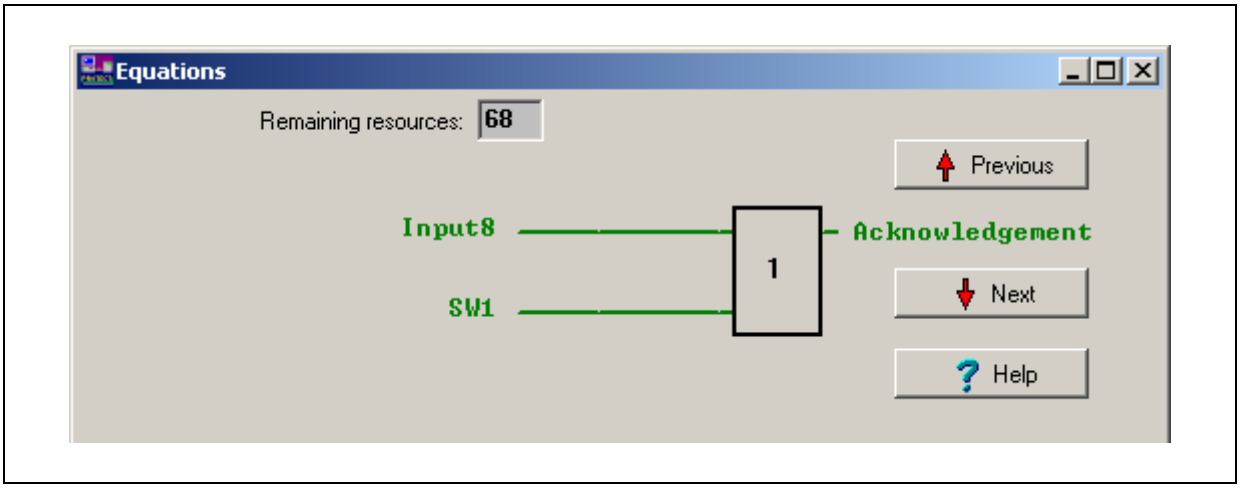

Fig. 2-22. Definition of the acknowledgement with a PROTLOG equation (example)

Parameter setting for latching of the LED-s:

Name	LCD	Min	Max	Step	Explanation
PLEDlatch	LED latching /+=yes/	-	+		LED latching

The setting on the „On-line" PC screen of the Protect for Windows software:

Fig. 2-23.Parameter setting /6

2.5.8.1 Setting guide

The parameter to be set is described in chapter 2.5.8. This guide refers to the parameter by the „Parameter name".

`PLEDlatch`
If the latching of the LED-s are set (the parameter is „+"), the possibility for acknowledgement is needed as well (Fig. 2-22. shows an example).

2.5.9 Displayed system messages

If any of the protection functions operates, or the self check system detects an error, then a message is displayed on the Front panel LCD. The following table lists the possible system message text elements.

```
EEPROM          error!
RAM battery discharged!
Self CHK:     A/D error!
 NO since last request!
    Protection trip!
DTI-KF-EP/IRT   2003.07.11.V1.01
    CB circuit error!
```

The message must be acknowledged by pressing the ENT (ENTER) pushbutton. The effect is that the message disappears. Wen more than one messages are active; the first acknowledgement displays the next message. After the last active message the normal display function will be active again, and the red LED announcing the active messages disappears.

The active messages are not displayed in the correct event sequence but according to the list above.

The messages of the protection functions and the self-check error messages are logged in the event recorder with time stamp. The log can store up to 50 events with scanned analogue values. The time resolution is 1 ms. In the digital event sequence recorder up to 300 digital events can be recorded. These recorded events are stored after acknowledgement as well. The event log can be displayed on the man-machine interface of the device, on the PC screen via serial line using the Protect for Windows software, and the events are sent to the supervisory and control system too.

2.5.10 Displayed values (Summary)

The algorithms as applied in the protection functions – as by-products – measure and calculate several quantities. These values can be displayed on the LCD of the device, they are listed on the PC screen when using Protect for Windows software, they are sent to the supervisory and control system, and as an option, if the device contains a large graphic display, they are shown here as well.

The measured values as default:

Value	Explanation
`Ir [A] =`	R phase current base harmonic
`Is [A] =`	S phase current base harmonic
`It [A] =`	T phase current base harmonic
`3Io [A] =`	Zero sequence current base harmonic

In case of optional voltage input module:

Value	Explanation
`Urs [kV] =`	RS line-to-line voltage base harmonic
`Ust [kV] =`	ST line-to-line voltage base harmonic
`Utr [kV] =`	TR line-to-line voltage base harmonic
`3Uo [kV] =`	Zero sequence voltage base harmonic

The status signals of the individual protection functions are summarised for the LCD as follows (the sequence means bits from right to left in the displayed status words):

Status word	Signal	Explanation
DTI2 status_1:	Ir>	Start of low current setting stage phase R overcurrent protection
	Ir>>	Start of high current setting stage phase R overcurrent protection
	Is>	Start of low current setting stage phase S overcurrent protection
	Is>>	Start of high current setting stage phase S overcurrent protection
	It>	Start of low current setting stage phase T overcurrent protection
	It>>	Start of high current setting stage phase T overcurrent protection
	Io>	Start of low current setting stage zero sequence overcurrent protection
	Io>>	Start of high current setting stage zero sequence overcurrent protection
DTI2 status_2:	Uo>	Start of the zero sequence overvoltage function
	EEPROM error	EEPROM error
	BATT error	RAM battery discharged
	AD error	A/D converter error
	5	No meaning
	6	No meaning
	7	No meaning
	8	No meaning

In case of optional voltage input module the calculated values:

Value	Explanation
P [kW] =	Three-phase active power
Q [kvar] =	Three-phase reactive power
Cos fi =	Power factor
Po [kW] =	Zero sequence active power
Qo [kvar] =	Zero sequence reactive power
Cos fio =	Zero sequence power factor

As an option, if the current input module is supplied by a measuring CT the following values can be calculated as well:

Value	Explanation
Power consumption[kWh] =	Active energy consumption
Reactive power[kvarh] =	Reactive energy consumption
Power access	Power excess
Overload	Overload

At the moment of event recording the measured analogue values are logged as well.

2.5.11 Self check function

The correct operation of the program system is supervised by a „Watch-dog" circuit. Additionally the program includes cyclic test routines as well. This self-check system supervises:

- all internal errors of the device, and
- if an output circuit test module is configured, the trip circuits are checked as well.

2.5.11.1 Internal error check

The internal error check supervises:

- the healthy state of the parameter memory,
- the power supply of the event memory (battery supported RAM),
- correct operation of the A/D converter.

In case of any detected problems the „UKE" input of the tripping matrix is set to logic „1". The same input gets „1", if the CB circuit test detects any error too.

2.5.11.2 Trip circuit check

If an output circuit test module is configured in the device, and the check is enabled then the continuous CB circuit test is carried out. The principle and the operation of this test are described in „*EPCP-2004*" documentation.

3 Communication with the device

3.1 The LCD menu system

The integrated menu system is described in „*EPCP-2004*" documentation.

The initial state of the LCD displays the type of the device, the date and the current time (day. month hours.minutes. seconds):

DTI-MV-EP
21.08 16:56:12

When pressing the ENT pushbutton, the menu system opens:

Events Test
Chk. Param.

3.1.1 The "Events" menu

When selecting the *Events* menu, the LCD shows the last stored event. Button ↓ steps to a previous event (button ↑ steps back). The list of the possible events in this device is as follows:

Event message	Explanation
I>>R start	High current setting stage start in phase R
I>>S start	High current setting stage start in phase S
I>>T start t	High current setting stage start in phase T
I>R start	Low current setting stage start in phase R
I>S start	Low current setting stage start in phase S
I>T start	Low current setting stage start in phase T
Io>> start	High current setting zero sequence stage start
Io> start	Low current setting zero sequence stage start
I>[t] timeout	Phase fault low current setting stage timeout
I>>[t] timeout	Phase fault high current setting stage timeout
Io>[t] timeout	Zero sequence low current setting stage timeout
3Io>>[t] timeout	Zero sequence fault high current setting stage timeout
3Uo>start	Zero sequence overvoltage stage start
3Uo>[t] timeout	Zero sequence overvoltage stage timeout
Urs<> start	Over/undervolatge stage start in phases RS
Ust<> start	Over/undervolatge stage start in phases ST
Utr<> start	Over/undervolatge stage start in phases TR
U<>[t] timeout	Over/undervolatge stage timeout

The „*Event*" menu displays the short messages with time stamp.

3.1.2 The "Test" menu

In this menu the LCD displays first the measured analogue values (The scale is primary Ampere). Steps among the displayed values by the arrow buttons (↓,↑).

Value	Explanation

`Ir [A] =`
`Is [A] =`
`It [A] =`
	Base harmonic RMS value of the phase current in primary Ampere

`3IoMeasured[A]=`
 	
`3IoCalculated[A] =`
	Zero sequence current component as measured in input Io
	Zero sequence current component as calculated based on the phase current

`Urs[V] =`
`Ust[V] =`
`Utr[V] =`
	Base harmonic RMS value of the phase-to-phase voltages.

`3Uosecondary [V] =`	The calculated zero sequence voltage in secondary Volts
`P3F[kW] =` `Q3F[kVAr]=`	Three-phase active power Three-phase reactive power
`DTI2 status_1 :` `DTI2 status_2 :`	Status words, see below

The meaning of „DTI2 status_1" is as follows:

DTI3 status_1:
11110111

Character ***1*** means active stat of a logic variable, ***0*** means reset state. The meaning of the bits from right to left:

```
Ir> start
Ir>> start
Is> start
Is>> start
It> start
It>> start
Io> start
Io>> start
```

When pressing button ↑ the second status word „DTI2 status_2" is displayed.

DTI3 status_2:
11110000

The meaning of the bits from right to left:

```
Uo> start
EEPROM error
Battery discharged
A/D error
- (internal signal)
- (internal signal)
- (internal signal)
- (internal signal)
```

A further step with ↑ button displays the counter values:

```
I>[t] counter :
I>>[t] counter :
Io>[t] counter :
Io>>[t] counter :
Uo>[t] counter :
U<>[t] counter :
```

3.1.2.1 The "test" menu

In this menu the parameter settings can be checked: Setting is not possible here, (See „Param." menu).

3.1.2.2 The "Version" menu

When selecting this menu item, the type of the device, the configuration and the version is displayed together with the date of the program compilation:

DTI-KF-EP/IRT
07.11.2003. V1.0

3.1.3 The "Param." menu

The *Param.* (parameter setting) menu can be used to set the protection parameters and the parameters for the communication and the software matrix as well.

The list of the parameters to be set and the setting limits with steps are explained in the function descriptions above.

3.1.3.1 Parameters concerning the communication:

The setting of the parameters for the communication is common for all EuroProt devices. See „*EPCP-2004*" documentation.

3.1.3.2 Password

The password protection is common for all EuroProt devices. See „*EPCP-2004*" documentation.

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3.2 Connection to an external PC

When connecting the device via serial line to an external PC, the man-machine conversation is more convenient, as the operation using local man-machine interface of the device. The operating program is „Protect for Windows", this software is delivered with the device, and the upgrading can be downloaded from the Protecta homepage free of charge. The details of operation with this software see in „*EPCP-2004*" documentation.

4 The local SCADA function

The CPU module of the device includes a dedicated microcontroller to perform special SCADA functions. This can be supported by a large optional graphic display on the front panel of the device. This function is common for all EuroProt devices. See „*EPCP-2004*" documentation.

5 Design of DTI-MV-EP devices

The information related wit the design of the devices is described „*EPCP-2004*" documentation.

The arrangement of the modules, the connections is specific to the ordered device. All these information is supplied as an attachment of the delivered device.

6 Ordering data

The ordering of the device is simple by completing the ordering formula, which is to be attached to the ordering. This formula contains the following information:

- Type of the EuroProt multifunctional device with DTI-MV-EP factory configuration
- Rated power supply voltage
- Rated current [1 A, 5 A]
- Zero sequence rated current [1 A, 5 A, 100 mA, 500 mA]
- Breaking capacity of the output contacts (2 A - 4 A)
- Type of zero sequence current transformer
- Design version of the device.
- SCADA options.
- Other options.